(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 August 2003 (28.08.2003)

PCT

(10) International Publication Number
WO 03/071213 A1

(51) International Patent Classification⁷: F28D 1/03, F28F 3/02, 3/12

(21) International Application Number: PCT/CA03/00225

(22) International Filing Date: 18 February 2003 (18.02.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2,372,399 19 February 2002 (19.02.2002) CA

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI,

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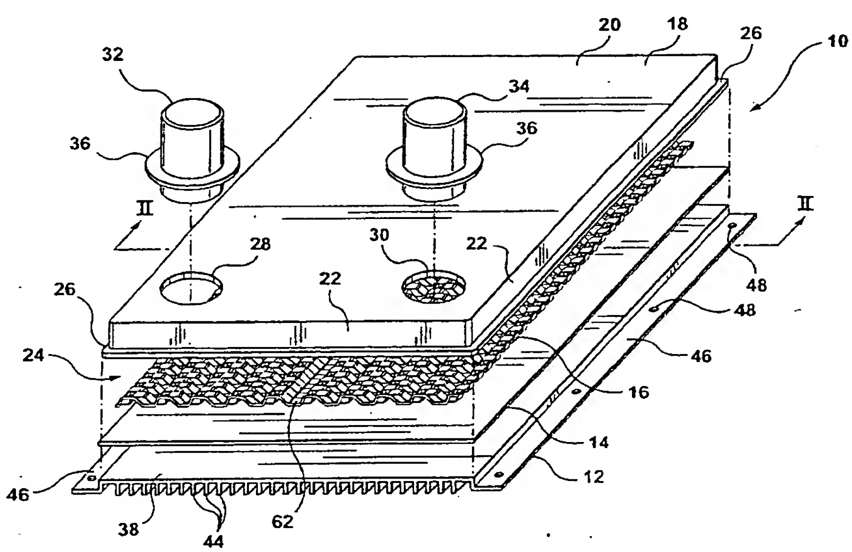
(54) Title: LOW PROFILE FINNED HEAT EXCHANGER



(57) Abstract: Low profile heat exchanger (10) including a fin plate (5) having opposite facing first and second sides (40, 42) and including a plurality of spaced apart elongate fins (44) that extend outward from the first side and define a plurality of elongate passages (50) that are open facing on the second side, and a flat container having spaced apart cover and shim plates (18, 14) sealably joined about peripheral edges thereof and defining a fluid conducting chamber (24), the container having an inlet opening (28) and an outlet opening (30) in communication with the fluid conducting chamber (24) to permit a fluid to pass into, through, and out of the fluid conducting chamber, wherein the first side (40) of the fin plate is mounted to the shim plate (14) to permit thermal transfer therebetween and the second side (42) of the fin plate is exposed.

WO 03/071213 A1

SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

LOW PROFILE FINNED HEAT EXCHANGER

BACKGROUND OF THE INVENTION

The present invention relates to low profile finned heat exchangers used for cooling fluid.

Low profile heat exchangers are typically used in applications where the height clearance for a heat exchanger is quite low, for example, slush box coolers in snow mobiles, and under-body mounted fuel coolers in automotive applications. One style of known low profile heat exchangers include a louvred plate that is exposed to air flow, snow and general debris, with a serpentine tube affixed to and passing back and forth across the plate. The fluid to be cooled passes through the serpentine tube. Another style of known low profile heat exchanger includes fins running transverse to and integrally extruded with top and bottom walls that are connected along opposite side edges to define a cavity that is welded shut at opposite ends after extrusion to provide a fluid cooling container.

Known low profile heat exchangers can be heavy and can be relatively expensive to manufacture. Thus, there is a need for a low profile heat exchanger that is relatively light weight and relatively cost efficient to manufacture. Also desired is a low profile heat exchanger that has an improved fluid temperature drop for its relative size.

SUMMARY OF THE INVENTION

According to the present invention there is provided a low profile heat exchanger that includes a fin plate having opposite facing first and second sides and including a plurality of spaced apart elongate fins that extend outward from the first side and define a plurality of elongate passages that are open facing on the second side, and a low profile container having spaced apart cover and shim plates sealably joined about peripheral edges thereof and defining a fluid conducting chamber, the container having an inlet opening and an outlet opening in communication with the fluid conducting chamber. The first side of the fin plate is mounted to the shim plate to permit thermal transfer therebetween and the second side of the fin plate is exposed.

According to another aspect of the present invention, there is provided a low profile heat exchanger that includes an extruded fin plate having a planar

support wall with opposite facing first and second sides and including a plurality of spaced apart elongate fins that extend outward from the second side and define a plurality of passages that are open facing away from the second side, and a separately formed low profile cover plate having a substantially planar central portion that is spaced apart from the first side of the support wall, the cover plate and support wall being joined about peripheral edges thereof and defining a fluid conducting chamber therebetween with an inlet opening and an outlet opening in communication with the fluid conducting chamber to permit a fluid to pass into, through, and out of the fluid conducting chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will be described, by way of example with reference to the following drawings.

Figure 1 is an exploded perspective view of a heat exchanger according to an embodiment of the invention.

Figure 2 is a sectional view taken along the lines II-II of Figure 1.

Figure 3 is a bottom plan view of the heat exchanger of Figure 1.

Figure 4 is an enlarged perspective view showing the turbulizer plate of the heat exchanger of Figure 1

Figure 5 is an enlarged scrap view of the portion of Figure 4 indicated by circle 5 in Figure 4.

Figure 6 is a plan view of the turbulizer plate of Figure 4.

Figure 7 is a top plan view of the heat exchanger of Figure 1

Figure 8 is a top plan view of a shim plate used in an embodiment of the heat exchanger.

Figure 9 is a sectional view taken along the lines IX-IX of Figure 8.

Figure 10 is a top plan view of a skeletal barrier plate used in an embodiment of the heat exchanger.

Figure 11 is a sectional view taken along the lines XI-XI of Figure 10.

Figure 12 is a top plan view of a heat exchanger according to another embodiment of the invention.

Figure 13 is a sectional view taken along the lines XIII-XIII of Figure 12.

Figure 14 is a bottom plan view of the heat exchanger of Figure 12.

Figure 15 is a bottom plan view of an alternative fin plate for use with embodiments of the heat exchanger of the present invention.

Figure 16 is a side elevational view of the fin plate of Figure 15.

Figure 17 is a bottom plan view of a further alternative fin plate.

Figure 18 is a top plan view of yet a further cover plate for use with the heat exchanger of the present invention.

Figure 19 is a top plan view of a further embodiment of a heat exchanger according to the present invention.

Figure 20 is a sectional view taken along the lines XX-XX of Figure 19.

Figure 21 is an exploded perspective view of another embodiment of a heat exchanger according to the present invention ad Figure 21A is a partial sectional view of an assembled portion of the heat exchanger taken along lines XXIA-XXIA of Figure 21.

Figure 22 is a top plan view of a further embodiment of a heat exchanger according to the present invention.

Figures 23A-23C are sectional views taken along the line XXIII-XXIII of Figure 22, each showing a different possible cover plate and shim plate combination according to embodiments of the present invention.

Figure 24 is a top plan view of a further embodiment of a heat exchanger according to the present invention.

Figures 25 is sectional views taken along the line XXV-XXV of Figure 24.

Figure 26 is a side elevational view of the heat exchanger of Figure 24.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to Figure 1, there is shown an exploded view of a heat exchanger, indicated generally by reference numeral 10, according a preferred embodiment of the invention. The heat exchanger 10 includes a bottom fin plate 12, a shim plate 14, a turbulizer plate 16, and a cover plate 18. The plates are shown vertically arranged in Figure 1, but this is for the purposes of explanation only. The heat exchanger can have any orientation desired.

Referring to Figures 1 and 2, the cover plate 18 together with the shim plate 14 define a flattened, low profile container having an internal fluid conducting chamber 24. The cover plate 18 includes a central planar portion 20 that is generally rectangular in the illustrated embodiment. A sidewall flange 22 is provided around all four peripheral edges of the central planar portion 20. The sidewall flange 22 extends towards the shim plate 14 providing a continuous sidewall about the fluid conducting chamber 24 that is defined between the cover plate 18 and the shim plate 14. Outwardly extending connecting flanges 26 are preferably provided along the bottom edges of at least one pair of opposing wall portions of the sidewall flange 22. Each connecting flange 26 has a planar surface 27 that abuts against and is secured to the shim plate 14.

A pair of fluid flow openings 28 and 30, one of which functions as a fluid inlet and the other of which is a fluid outlet, are provided through the central planar portion 20 in communication with the fluid conducting chamber 24. In one embodiment, cylindrical fittings 32, 34 having flow passages therethrough are provided for openings 28,30. The fittings 32, 34 may have annular flanges 36 sealably connecting the fittings to the cover plate 18.

In a preferred embodiment the cover plate 18 is of unitary construction and made of roll formed or stamped aluminum alloy that is braze clad.

The shim plate 14 is simply a flat plate having a first planar side that faces an inner side of the central planar portion 20 of the cover plate 18, and an opposite planar side 37 that faces and is connected to the fin plate 12. The shim plate 14 is substantially rectangular in the illustrated embodiment, having a footprint that is approximately the same as the footprint of the cover plate 18. Shim plate 14 is, in a preferred embodiment, made from a braze clad aluminum or

aluminum alloy sheet.

The fin plate 12 is, in one preferred embodiment, a unitary structure formed from extruded aluminum or aluminum alloy. The fin plate 12 includes a flat support wall 38 having a first planar side 40 facing and secured to the shim plate 14, and an opposite facing side 42 on which is provided a plurality of elongate, parallel fins 44. Mounting flanges 46 having securing openings 48 therethrough may be provided along opposite side edges of the support wall 38 to allow the heat exchanger to be mounted to a surface.

With reference to Figures 2 and 3, the fins 44 each run substantially from a first end to a second end of the support wall 38, and define a plurality of elongate passages 50 therebetween. The side of the fin plate 12 facing away from the shim plate 14 is open such that alternating fins 44 and passages 50 are exposed so that ,in use, air can flow through the passages 50 and over fins 44. In some applications, other substances such as water and snow and other debris may be thrown against the exposed fins and passages. In the heat exchanger shown in Figures 1-3, the fins 44 are straight fins, that each extend a uniform distance at a perpendicular angle from the outer planar side 42 of the fin support wall 38, and which run from one end to an opposite end of the heat exchanger .

The turbulizer plate 16 is located in the fluid conducting chamber 24 to augment fluid flow therein and thereby increase the efficiency of heat removal from the fluid. With reference to Figures 4,5, 6 and 7, in a preferred embodiment, the turbulizer plate 16 is formed of expanded metal, namely aluminum, either by roll forming or a stamping operation. Staggered or offset transverse rows of convolutions 64 are provided on turbulizer plate 16. The convolutions have flat bottoms and tops 66 to provide good bonds with cover plate 18 and shim plate 14, although they could have round tops, or be in a sine wave configuration, if desired. Part of one of the transverse rows of convolutions 64 is compressed or roll formed or crimped together to form transverse crimped portions 68 and 69 (crimped, as used herein, is intended to include crimping, stamping, roll forming or any other method of closing up the convolutions in the turbulizer plate 16) . Crimped portions 68,69 form a barrier 62 to reduce short-circuit flow inside the fluid conducting chamber 24. The barrier 62 is represented using phantom lines in Figure 7, and runs between the flow openings 28 and 30 so that fluid entering at one opening 28 or 30 simply cannot take a straight path through the convolutions 64 in the fluid chamber 24 and exit at the other flow opening 30 or 28, but rather

must take a more circuitous route. In the illustrated embodiment in which the two flow openings 28, 30 are located near a common end 60, the barrier 62 extends from close to the common end 60 to a point 72 that is set off from the opposite end 58 of the heat exchanger 10 such that a substantial portion of the fluid flowing into the chamber 24 from opening 28 must flow in a U-shaped flow path around point 72, as indicated by arrow 74, prior to exiting the chamber 24 through opening 30 (in the case where opening 28 is the inlet and opening 30 is the outlet for chamber 24). In a preferred embodiment, the cover plate 18 and the shim plate 14 are formed from braze clad aluminum, and the heat exchanger 10 is constructed by assembling the parts in the order shown in Figure1, clamping the parts together and applying heat to the assembled components in a brazing oven, thereby sealably brazing the cover plate side wall flange 22 about its lower end to the shim plate 14 with the turbulizer plate 16 sandwiched between the cover plate 18 and shim plate 14, and brazing the shim plate 14 to the support wall 38 of the fin plate 12. Soldering could, in some applications, be used in place of brazing fro connecting the components together. Other metallic materials, for example steel, and non-metallic polymer materials could be used to form some or all of the components of the heat exchanger for some embodiments. Polymer components could be thermally bonded together, ultrasonically bonded, or bonded using adhesive or other means.

The heat exchanger 10 can conveniently be used as a low-profile device for cooling a fluid that passes through the fluid flow container defined by the cover plate 18 and shim plate 14, with heat from fluid being conducted away from the fluid to exposed fins 44, which in turn are cooled by air passing there through. In some applications, the cooling of exposed fins 44 is assisted by other substances such as snow and water that gets thrown against the exposed fins 44. The heat exchanger 10 can be used, for example, as an engine coolant cooler in a snowmobile, or as an underbody mounted fuel cooler in an automotive application, although these examples are not exhaustive.

The heat exchanger 10 can be manufactured in different sizes relatively easily by extruding longer fin plates 12 and roll forming correspondingly longer shim and cover plates 14,18. Although the cover plate 18 has been described above as having an integrally formed sidewall flange 22, in some embodiments, separate sidewalls may be used. Furthermore, in some embodiments, shim plate 14 could be omitted, and in its place the upper side of the support wall 38 used as

the bottom wall for the fluid conducting chamber 24. Although the heat exchanger 10 has been illustrated as being rectangular, it could also have different shapes - for example it could have a circular disc-like configuration in some applications.

A variety of different types of turbulizers or flow augmentation means can be used in the fluid conducting chamber 24, and in some applications, the turbulizer plate 16 may not be present. Furthermore, a short-circuit barrier different than crimped barrier 62 could be used in some embodiments. In this regard, Figures 8 and 9 show a further shim plate 78 that could be used in place of shim plate 14 in the heat exchanger 10. The shim plate 78 has a central elongate baffle wall 80 extending transversely upward therefrom to the cover plate 18 (not shown in Figure 8). The baffle wall 80 is positioned between locations at which the flow openings 28 and 30 are provided through the cover plate 18 (such locations being illustrated by the phantom lines 28' and 30' in Figure 8) such that baffle wall causes the fluid in chamber 24 to follow an indirect U-shaped flow path as indicated by flow arrow 82. The baffle 80 is preferably formed from a portion of the shim plate 78 that has been stamped out along three side edges and then pivoted upwards about a fourth side edge that remains connected to the rest of the shim plate 78, leaving a rectangular opening 84 through the shim plate 78 that is sealably blocked by the support wall 38. Separate turbulizer plates can be located on opposite sides of the baffle wall 80.

Figures 10 and 11 show a skeletal baffle plate 86 that can be used in place turbulizer plate 16 between shim plate 15 and cover plate 18 in a further alternative embodiment of heat exchanger 10. The positions of flow openings 28 and 30 relative to the skeletal baffle plate 86 are illustrated by phantom lines 28' and 30' in Figure 10. The skeletal baffle plate 86 includes an outer rectangular frame 88 that is dimensioned to snugly fit within the sidewall flange 22 of the cover plate 18. The skeletal baffle plate 86 has a height H (see Figure 11) that conforms to the height of the fluid chamber 24, and includes alternating substantially parallel baffle walls 90,92. Baffle walls 90 extend from a first end wall 94 near where the flow openings 28, 30 are positioned, to close to an opposite end wall 96. Alternating baffle walls 92 extend from the opposite end wall 96 to close to the first end wall 94, such that baffle walls 90 and 92 collectively define a serpentine back and forth flow path through the fluid chamber 24, as illustrated by flow arrows 98 in Figure 10 (which assume that opening 28 is the higher pressure opening). In alternative embodiments, baffle walls such as those provided by skeletal baffle

plate 86 could instead be provided by embossed ribs formed on the shim plate 14 or on the cover plate 18 or on both, and in many applications embossed ribs on the cover and/or shim plate will be preferred to a separate baffle plate as it reduces the number of components that need to be assembled. Numerous examples of embossed cover plate configurations suitable for use with the heat exchanger 10 are presented below.

In some applications, it may be desirable to use a fin plate that is lighter weight than extruded fin plate 12. With reference to Figure 12-14, a further embodiment of a low profile heat exchanger, indicated generally by reference numeral 100, is shown in accordance with another preferred embodiment of the invention. The heat exchanger 100 is similar to heat exchanger 10, except for differences that will be apparent from the following description. Heat exchanger 100 has a generally rectangular footprint, and as best seen in Figure 13, similar to heat exchanger 10, is a lamination of a fin plate 102, a shim plate 104, and a cover plate 106. In the illustrated embodiment, the cover plate 106 includes a rectangular central planar ribbed portion 108 that is roll formed or stamped from braze clad aluminum or aluminum alloy. A sidewall flange 110 extends continuously about an outer periphery of the central planar portion 108 towards the shim plate 104, with an out-turned edge 112 of the sidewall flange 110 having a planer portion facing and sealably connected to the shim plate 104. The shim plate 104 and cover plate 106 of the heat exchanger 100 collectively define therebetween a fluid conducting chamber 113 that includes a flow path between a first flow opening 114 and a second flow opening 116 that are provided through the cover plate 106 at diagonally opposite corners thereof. On of the flow openings 114, 116 is a fluid inlet into the fluid conducting chamber 113, and the other is a fluid outlet. In the embodiment illustrated, each opening 114, 116 is provided with a corresponding fitting 122 that is brazed to the cover plate 106 and which has a flow passage through it that is parallel to the plane of central portion 108.

The flow path between the openings 114, 116 is broken up into a serpentine back and forth route by alternating embossed baffle ribs 118 and 120 formed in the central portion 108 of the cover plate 106. In particular spaced apart parallel ribs 118 extend from a first end 124 of the cover plate 106 to close to, but spaced apart from the opposite end 126 of the cover plate 106. Alternating parallel ribs 120 extend from the end 126 to close to, but spaced apart from the first end

124. As best seen in Figure 13, each of the ribs 118,120 includes a pair of opposed elongated sidewalls 128 that are joined together along their distal edges by a flat portion 130 having a planar surface for forming a good bond with the shim plate 104.

Brackets 132 may be brazed to the cover plate 108 to permit the heat exchanger 100 to be fastened in place. The brackets 132 shown in Figures 12 and 13 each have a substantially rectangular central body with a portion that extends beyond the cover plate having a securing hole 134 therethrough. The bracket center body 132 located on the cover plate 108 is dimensioned to run between two adjacent ribs 120, 118, and preferably includes opposed positioning tabs 136 that extend into the ribs 120, 118 to assist in positioning and securing the bracket 132 in place. In some applications, due to its light-weight configuration, the heat exchanger may be sufficiently supported by tubing connected to the inlet and outlet fittings, and additional brackets not required.

The shim plate 112 is simply a flat rectangular plate formed from braze clad aluminum or aluminum alloy. The fin plate 102 is secured to a side of the shim plate 112 that is opposite the fluid chamber 113 for drawings heat away from the fluid chamber, and is substantially rectangular, covering substantially the entire shim plate. The fin plate 102 has one side that is secured to the shim plate 104 and an opposite side that is exposed. As best seen in the sectional view of Figure 13 and the bottom plan view of Figure 14, the fin plate 102 includes a plurality of spaced apart elongated hollow fins 138 that extend outward from and run the length of the shim plate 104, each formed by a generally U-shaped wall. The fins 138 define a plurality of open faced air passageways 140, that are spaced apart by closed-face passageways 142 located within each fin 138. The transverse ends of the fin plate 102 may be open so that the closed-face passageways 142 are open at opposite ends thereof. Each of the U-shaped fins 138 is connected to an adjacent fin 138 by a planar connecting wall 144 that is secured by brazing to the shim plate 104. In effect, the U-shaped fins 138 and connecting walls 144 collectively form a square-corner corrugation. As seen in Figure 14, the fins 138 are formed to have a uniform size, but with soft undulating curves along their length to assist in interrupting the boundary layer of any air flowing therethrough. The fins 138 are preferably light-weight and roll-formed or stamped from aluminum or aluminum alloy. In the illustrated embodiment, the alternating open-faced and closed-face passages 140,142 each have substantially the same cross-

sectional area , however different relative areas could be used depending on the application. Also, different fin profiles could also be used, for example, V-shaped fins could be used.

Figure 15 shows an example of a further fin plate structure 146 that could be used on the underside of shim plate 14, 104 of the heat exchangers 10, 100. The fin plate 146 has a first side 148 that is brazed to the shim plate, and a second exposed side 150. A plurality of open-faced air passageways 152 run from a first end 154 to a second end 156 of the fin plate 146 between elongate fin structures that are made up of staggered or offset transverse rows of convolutions 158. The convolutions have flat tops 160 to provide good bonds with the shim plate 14, 104, although they could have round tops, or be in a sine wave configuration, if desired. In a preferred embodiment, the fin plate 146 is formed of expanded metal, namely aluminum, either by roll forming or a stamping operation.

Figure 17 shows a bottom view of yet another possible fin plate configuration. The fin plate 162 of Figure 17 is the same as fin plate 102, except that the hollow U-shaped fins 164 (which define spaced-apart open-faced passages 166), are arranged in back and forth herringbone pattern.

In addition to the cover plates 18, 106 described above, many other planar cover plate configurations are possible. By way of example, Figure 18 illustrates a further possible cover plate 168 according to the present invention that is identical to the cover plate 18, with the exception that the alternating embossed ribs 170 and 172 extend in a direction that is relatively perpendicular to the ribs 118 and 120 of cover plate 106, and the ribs 118 and 120 each formed with undulating curves along there length, defining a transverse serpentine flow path as illustrate by arrows 174 between flow openings 114 and 116. Instead of the embossed baffle ribs being formed on the cover plate, they could alternatively be formed on the shim plate, in which case the shim plate would have a plan view similar to that shown in Figure 18, but without flow openings formed therethrough. Alternatively, both the cover plate and shim plate could have embossed ribs formed thereon that sealably abut together to define the flow path through the fluid chamber, in which case both the cover and shim plate would have a top and bottom plan view, respectively, similar to the plan view of Figure 18 (with the shim plate not having flow openings therethrough), with the embossed ribs 170,172 on each of the cover and shim plate each having a depth of about one-half the fluid chamber height. It will be appreciated that many different patterns of embossed ribs and other types

of embossed flow augmenters or barriers could be provided the cover or shim plates.

By way of example, Figures 19 and 20 show a further heat exchanger 190' that is substantially identical to heat exchanger 100, except that it has a cover plate 192 in which are embossed a plurality of dimples 194. The dimples 194 extend to and engage the shim plate 104, thereby providing flow augmentation in the fluid chamber 113.

Yet another heat exchanger, indicated generally by reference numeral 200, is shown in exploded view in Figure 21. Heat exchanger 200 is substantially identical to heat exchanger 100, with the exception of differences that are apparent from the drawings and the following description. The cover plate 202 of heat exchanger 200 does not include embossed ribs thereon for defining the flow path within fluid chamber 113, but rather, a corrugated baffle plate 204 (formed from aluminum of another suitable material) is secured in the fluid chamber 113 between the cover plate 202 and shim plate 104. The corrugated baffle plate 204 includes a plurality of substantially parallel pairs of first and second barrier walls 206A,206B that run from one end 208 to an opposite end 210 of the fluid chamber 113. The barrier walls 206A and 206B in each pair are joined together along upper first longitudinal edges thereof by a planar wall that abuts against and is secured to the inside of the cover plate 202. (Orientational terms like "upper" and "horizontal" being used herein for explanatory purposes only as the heat exchanger can have any orientation in use). The pairs of barrier walls are joined together along their lower edges by a further wall 214 that abuts against and is secured to the shim plate 104 - in particular, the barrier wall 206B of one pair is connected at the lower edge thereof to lower edge of the barrier wall 206A of the adjacent barrier wall pair. A transverse flow opening 216 is provided at the end of each barrier wall 206A near the end 208 of the heat exchanger, and a transverse flow opening 218 is provided at the end of each barrier wall 206B near the opposite end 210 of the heat exchanger 200. Thus, parallel alternating flow passages are defined in fluid chamber 113 by the barrier walls 206A, 206B, with the barrier wall openings 216, 218 permitting serpentine back and forth fluid flow through the passages form one flow opening 116 to the other flow opening 114 (or vice versa, depending on which is the high pressure opening).

With reference to Figure 21A, in one embodiment, the corrugated barrier plate 204 includes planar horizontal portions 220 forming its outer longitudinal

edges, and the portions 220 are sandwiched between the lower connecting flange 26 of the cover plate 202 and the shim plate 104.

With reference to Figures 22-23C, further alternative cover plate and shim plate configurations for the heat exchanger 200 will now be discussed. Turning first to Figures 22 and 23A, in one embodiment the cover plate 230 is dish shaped, having a central planar portion 240 having an integral, peripheral, downwardly extending flange 242 that defines an angle of slightly greater than 90 degrees with respect to an inner surface of central planar portion 240. The shim plate 236 is identical, except that it does not have openings 116, 114 formed therethrough, and the downwardly extending flange 244 of the shim plate 236 is nested within and supported by the flange 242 of the cover plate 240, with fluid chamber 113 being defined between the planar central portions of cover plate 240 and shim plate 236. The fin plate 102 (shown having fins with rounded corrugations rather than square) is secured to a lower surface of the planar central portion of the shim plate 244. The shim plate flange 244 could be truncated just at or under the bottom edge of cover plate flange 242 to minimize any adverse effect on air flow through fin plate 102.

Figure 23B shows a similar configuration, except that the shim plate 238 has an upwardly turned peripheral flange 246 that extends in the opposite direction of cover plate flange 242, and which has an outer surface that is nested within and brazed to an inner surface of cover plate flange 242. The configurations shown in Figures 23A and 23B could be easily "flipped over" with the fin plate being placed on the opposite side, as shown by phantom line 102' in Figure 23B. Furthermore, in some embodiments, fin plates may be used on both sides of the heat exchanger.

Figure 23C shows a further configuration in which the cover plate 234 and shim plate 248 are identical (except that there are no flow openings in the shim plate), each having an abutting flange 250,252 formed about a central planar portion thereof.

Figure 24 shows a further heat exchanger 260 that is identical to heat exchanger 100 except for the differences noted below. The cover plate 262 of heat exchanger 260 includes a plurality of air flow openings 264 punched therethrough. Each of the openings 264 is aligned with a respective opening 268 provided through the shim plate 266. Each cover plate air flow opening 264 is

surrounded by a wall 265 about its peripheral edge that extends from the cover plate to the shim plate to seal the air opening off from the fluid chamber 113. The walls 265 are preferably extruded from the cover plate material when the openings 264 are punched. Aligned openings 264, 268 are located at areas where the fin plate 102 does not contact the shim plate, so that the aligned openings are not completely blocked by the fin plate 102. In some embodiments, corresponding openings may be punched through the fin plate 102. As illustrated in figure 26, in use, air can flow through the openings 268,264, thereby allowing air to flow through sealed off sections of the fluid container defined by the shim and cover plates. As indicated in Figure 26, the heat exchanger may be angled relative to the direction of travel (arrow 270) in some applications to improve performance by increasing the attack angle at which air hits the fin plate 102.

Many components of the heat exchanger of the present invention have been described as being made from aluminum or aluminum alloy, however it will be appreciated that other metals could suitably be used to form the components, and in some applications non-metallic materials might be used, including for example thermally bondable, ultrasonically bondable, and adhesive bondable polymers. As will be apparent to those skilled in the art, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

What is claimed is:

1. A low profile heat exchanger comprising:

a fin plate having opposite facing first and second sides and including a plurality of spaced apart elongate fins that extend outward from the first side and define a plurality of elongate passages that are open facing on the second side; and

a low profile container having spaced apart cover and shim plates sealably joined about peripheral edges thereof and defining a fluid conducting chamber, the container having an inlet opening and an outlet opening in communication with the fluid conducting chamber,

wherein the first side of the fin plate is mounted to the shim plate to permit thermal transfer between the low profile container and the fin plate, and the second side of the fin plate is exposed.

2. The heat exchanger of claim 1 wherein the shim plate is a planar sheet and the cover plate has a substantially planar central portion and an integral sidewall flange provided about a peripheral edge of the central portion extending towards and sealably connected to the shim plate.

3. The heat exchanger of claim 2 wherein a lateral connecting flange is provided at a peripheral edge of the sidewall flange, the connecting flange having a planar surface that abuts and is connected to the shim plate.

4. The heat exchanger of anyone of claims 1 to 3 wherein a turbulizer having rows of fluid flow augmenting convolutions is located in the fluid conducting chamber.

5. The heat exchanger of claim 4 wherein a plurality of the convolutions are crimped to provide a barrier to direct fluid flow between the inlet and outlet openings.

6. The heat exchanger of anyone of claims 1 to 3 wherein a skeletal frame having a plurality of barrier walls is located in the fluid conducting chamber providing a serpentine flow path therethrough between the inlet and outlet openings.

7. The heat exchanger of anyone of claims 1 to 3 wherein at least one of the cover plate and the shim plate has a plurality of embossed ribs formed thereon that extend into the fluid conducting chamber providing a serpentine flow path therethrough between the inlet and outlet openings.

8. The heat exchanger of anyone of claims 1 to 7 wherein the fin plate is a corrugated plate with the elongate fins defining open-ended passages that face the shim plate and that alternate with the passages that are open facing.

9. The heat exchanger of claim 8 wherein the fins are U-shaped in transverse cross-section, and are joined by connecting walls that are brazed or soldered to the shim plate.

10. The heat exchanger of claim 9 wherein the fins are longitudinally curved in alternating directions to break a boundary layer of air flowing therethrough.

11. The heat exchanger of claim 9 wherein the fins are longitudinally angled in alternating directions in a herringbone-type pattern to break a boundary layer of air flowing therethrough.

12. The heat exchanger of anyone of claims 1 to 7 wherein each fin is a longitudinal row of generally U-shaped transverse convolutions provided in the fin plate, at least some of the convolutions in each row being transversely offset along the row relative to other convolutions in the row.

13. The heat exchanger of anyone of claims 1 to 12 wherein the inlet and outlet openings are formed through the cover plate in locations opposing the shim plate.

14. The heat exchanger of anyone of claims 1 to 3 and 13 wherein the fin plate includes a planar support wall defining the first side from which the fins extend, the shim plate having a portion that is partially separated from a rest of the shim plate and bent to project into the fluid conducting chamber for providing flow circuiting therein.

15. The heat exchanger of anyone of claims 1 to 3 and 13 wherein a plurality of dimples extend inwardly from the cover plate into the fluid conducting chamber for augmenting fluid flow therein.

16. The heat exchanger of anyone of claims 1 to 3 and 13 including a corrugated baffle plate located in the fluid conducting chamber for circuiting flow therethrough, the baffle plate including a plurality of parallel baffle walls extending substantially from a first end to a second end of the fluid conducting chamber defining a plurality of parallel flow paths therethrough, a flow opening being provided in each of the baffle walls to circuit fluid through the fluid conducting chamber.

17. The heat exchanger of claim 1 wherein the cover plate and shim plate each have planar central portions peripherally surrounded by an integral sidewall flange, the sidewall flange of one of the cover and shim plate being nested within and sealably connected to the sidewall flange of the other.

18. The heat exchanger of claim 1 wherein the cover plate and shim plate each have a planar central portion peripherally surrounded by an integral sidewall flange that is peripherally surrounded by a lateral connecting flange, the connecting flanges of the cover plate and shim plate having sealably connected abutting planar surfaces.

19. The heat exchanger of anyone of claims 1 to 18 wherein a plurality of air flow passages that extend through the shim plate, the fluid conducting chamber and the cover plate, are provided through the low profile container, the air flow passages each being sealed from the fluid conducting chamber.

20. The heat exchanger of claim 19 wherein the fin plate defines air passages which are in flow communication with the air flow passages through the low profile container.

21. A low profile heat exchanger comprising:

an extruded fin plate having a planar support wall with opposite facing first and second sides and including a plurality of spaced apart elongate fins that extend outward from the second side and define a plurality of passages that are open facing away from the second side; and

a separately formed low profile cover plate having a substantially planar central portion that is spaced apart from the first side of the support wall, the cover plate having an integral sidewall flange about a peripheral edge thereof, the

sidewall flange extending towards the support wall and having a lateral connecting flange at an extending edge thereof, the connecting flange having a substantially planar surface that is sealably connected to the first side of the support wall, a fluid conducting chamber being defined between the cover plate and the support wall with an inlet opening and an outlet opening in communication with the fluid conducting chamber to permit a fluid to pass into, through, and out of the fluid conducting chamber.

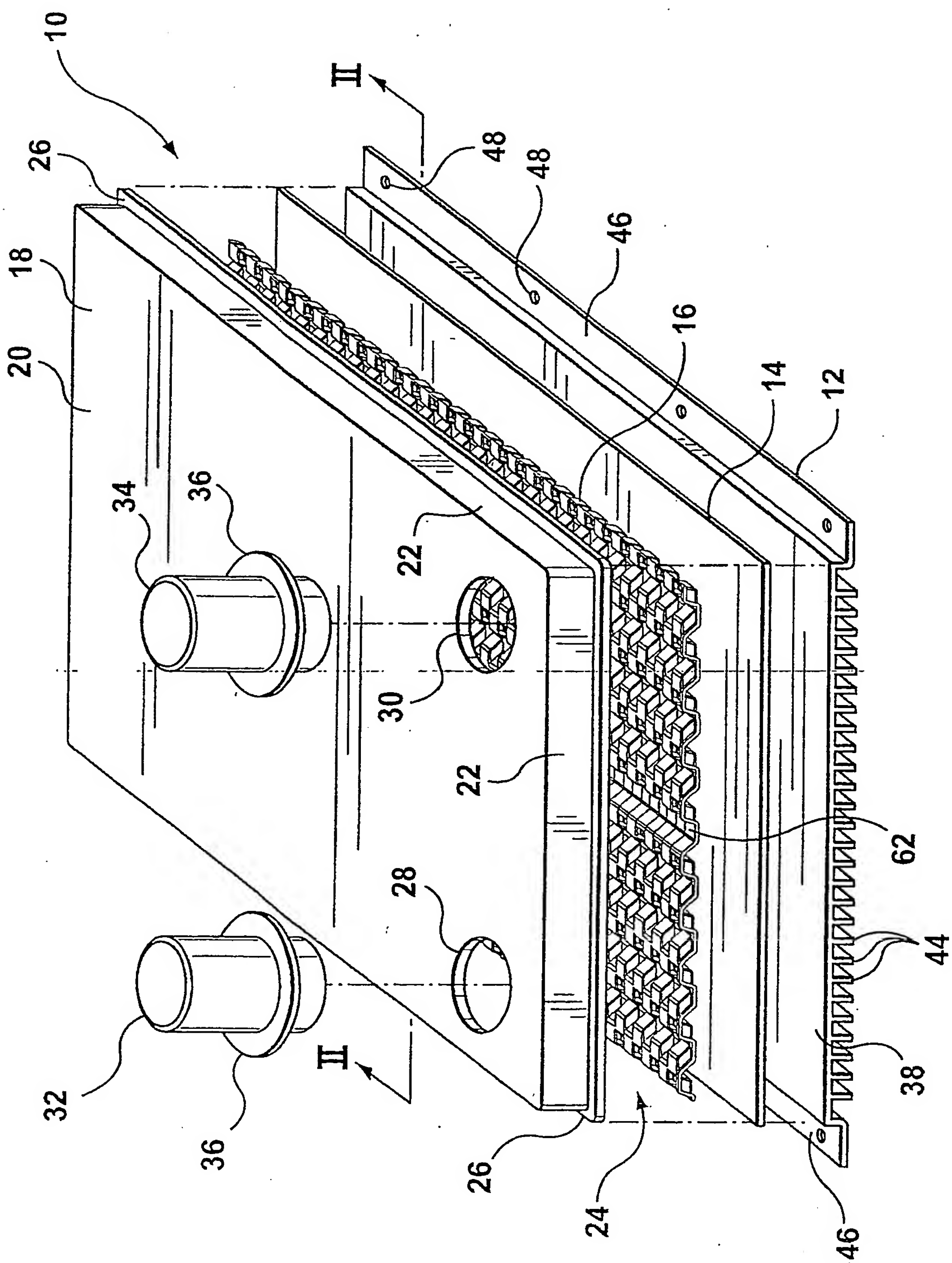

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FIG. 1

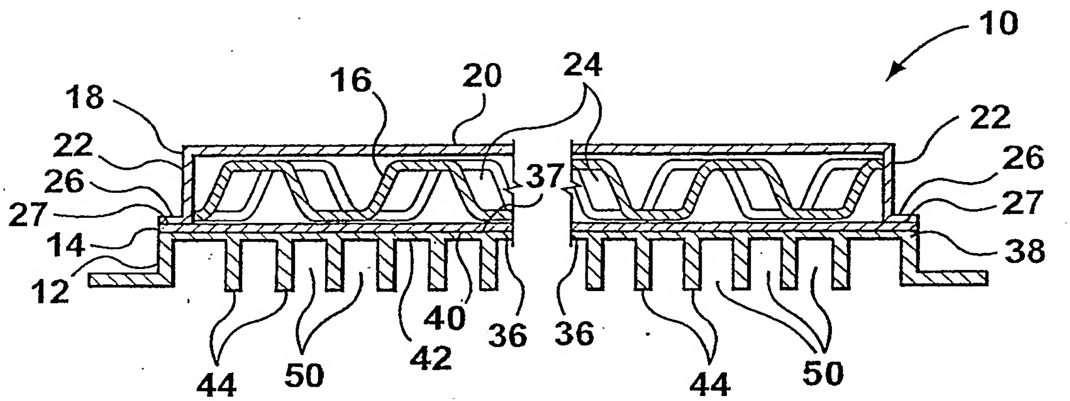
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FIG. 2

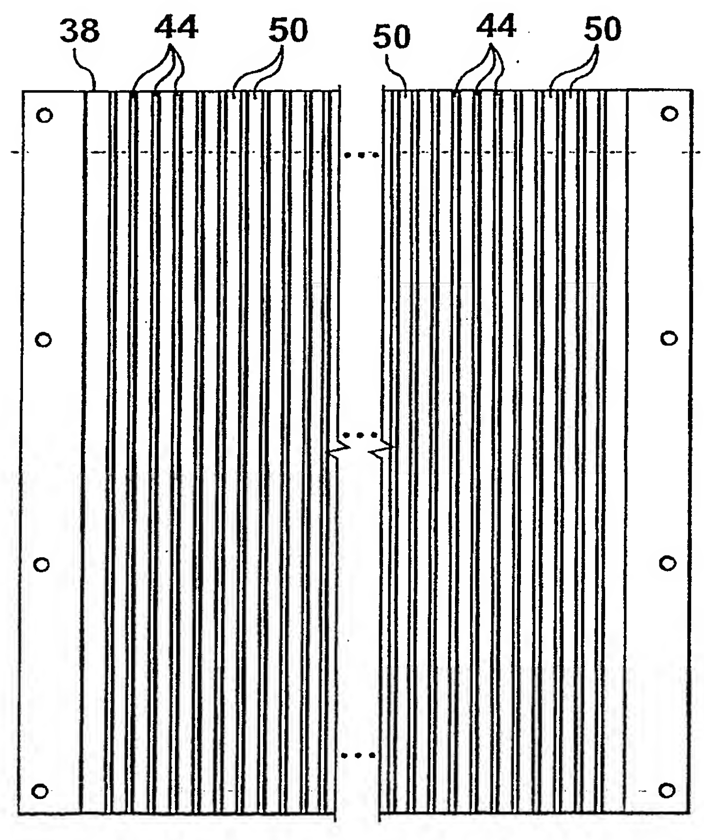
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FIG. 3

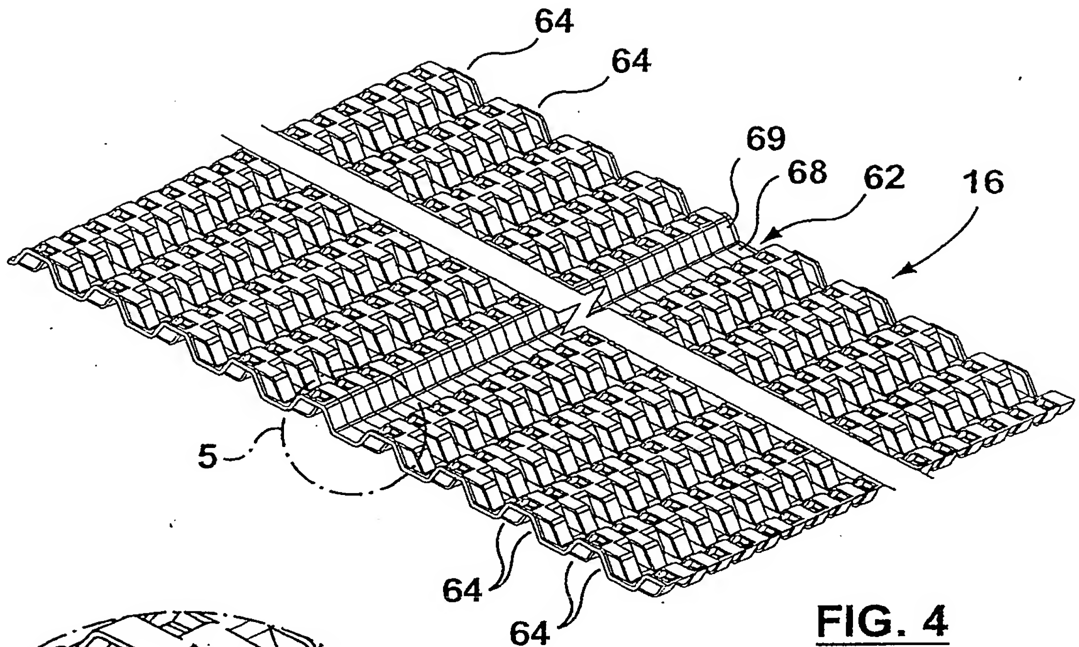

FIG. 4

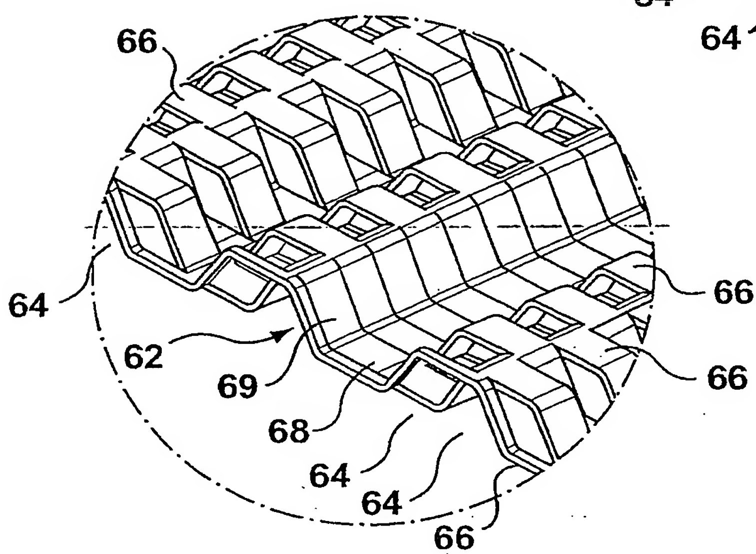

FIG. 5

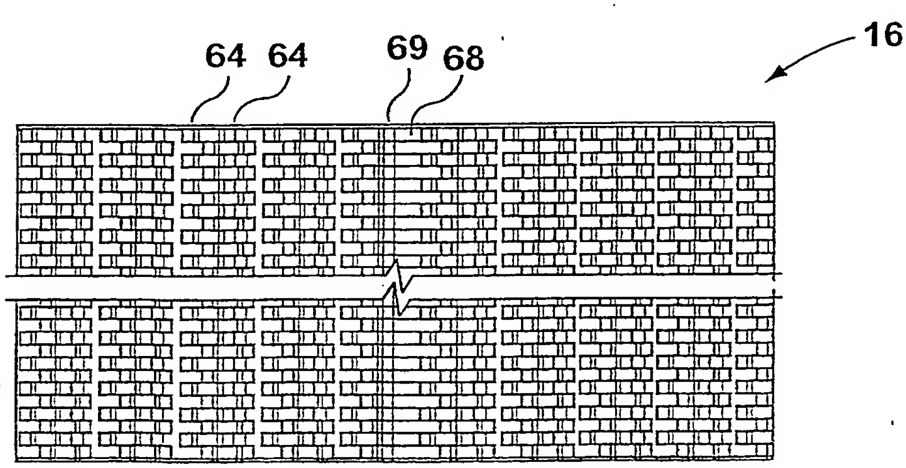

FIG. 6

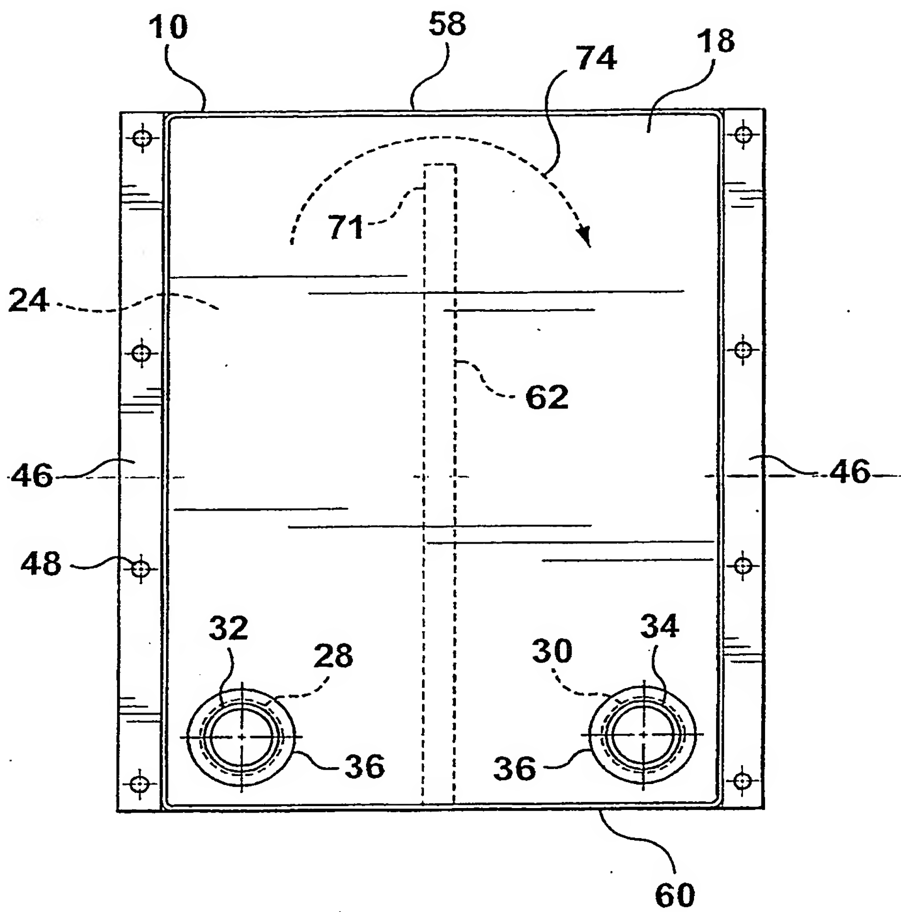

FIG. 7

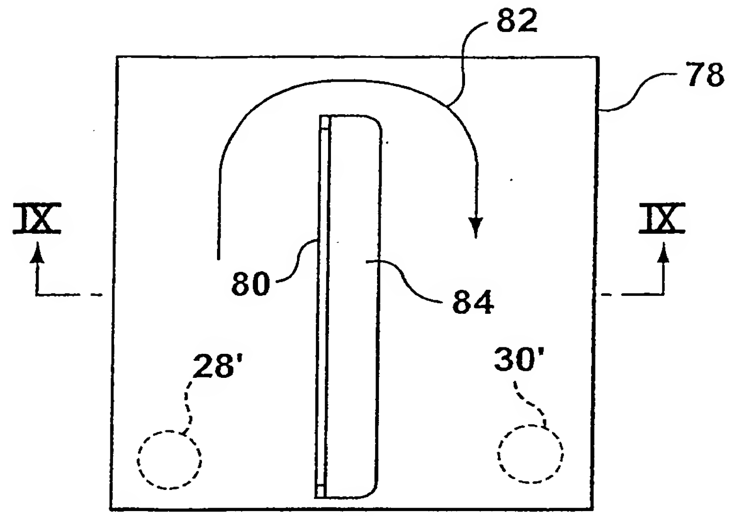

FIG. 8

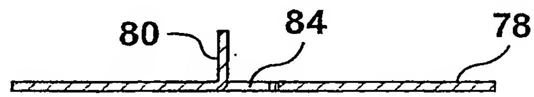

FIG. 9

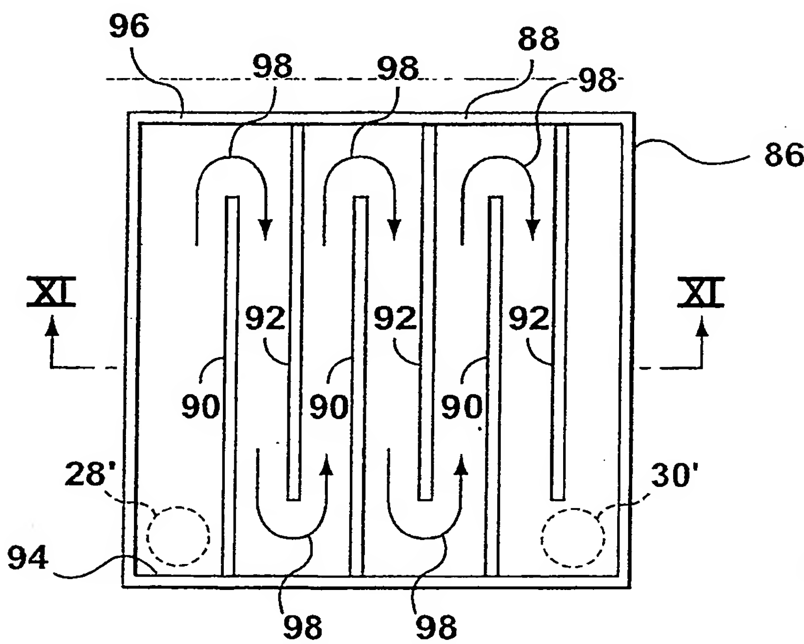

FIG. 10

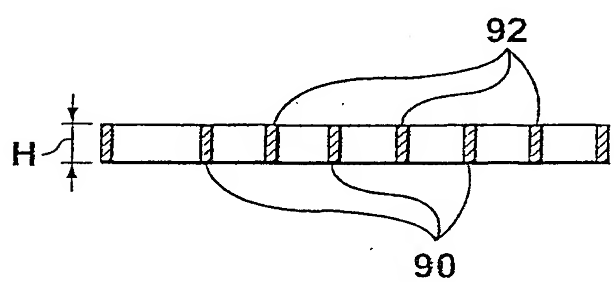

FIG. 11

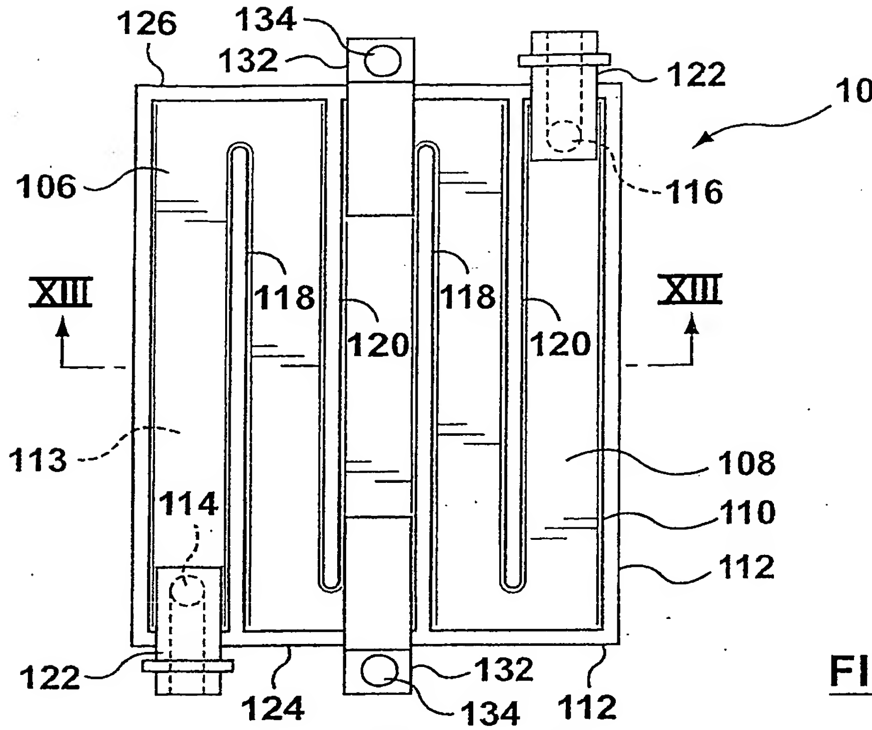

FIG. 12

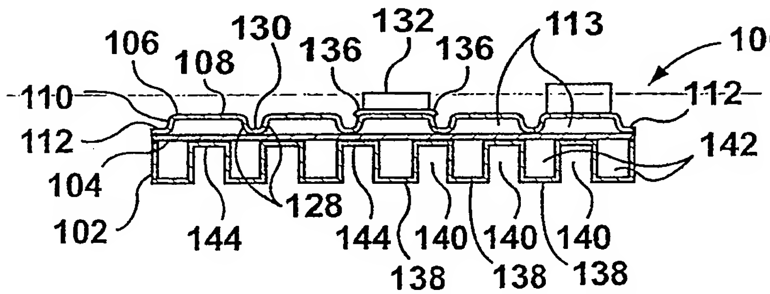

FIG. 13

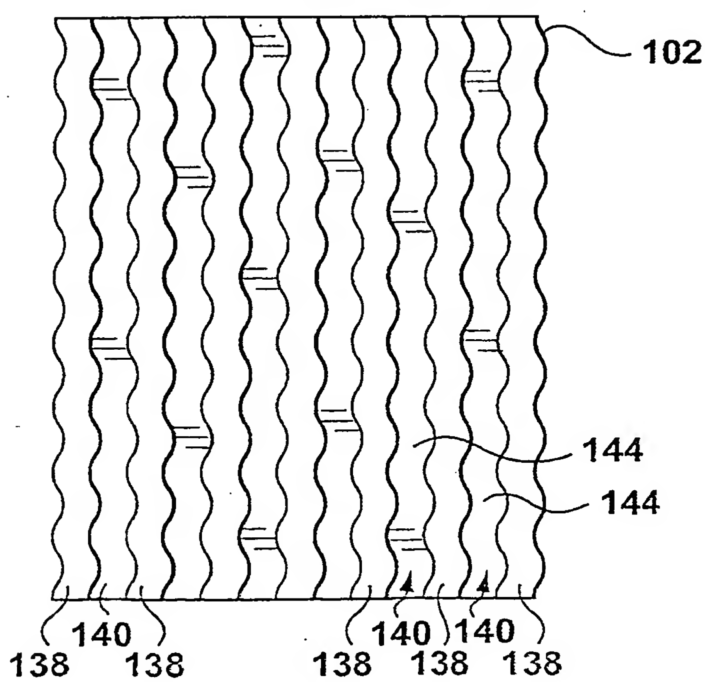

FIG. 14

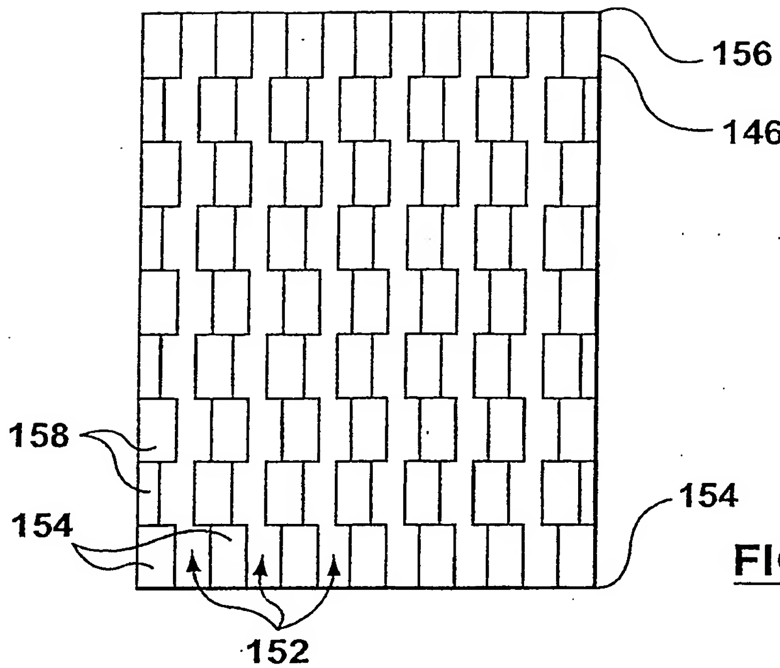

FIG. 15

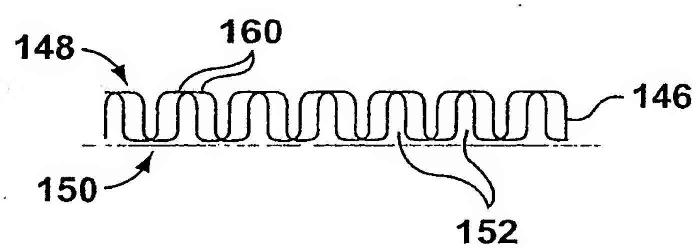

FIG. 16

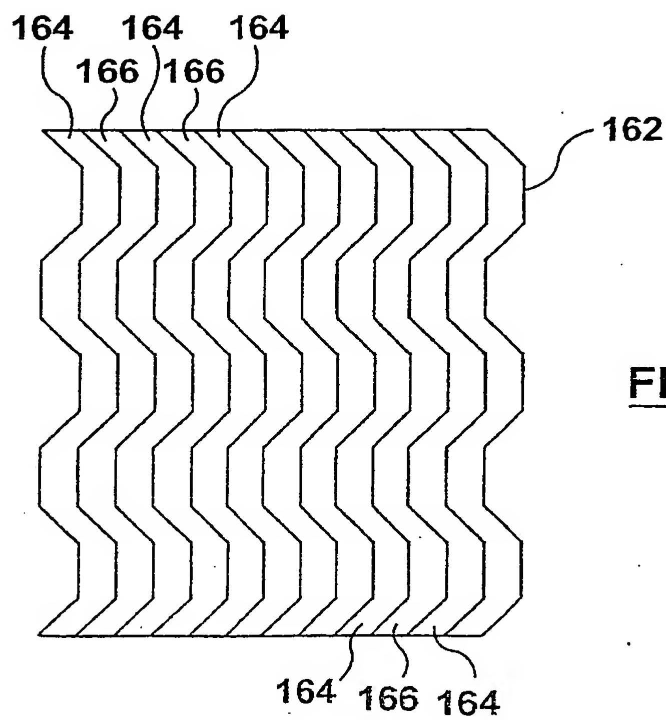

FIG. 17

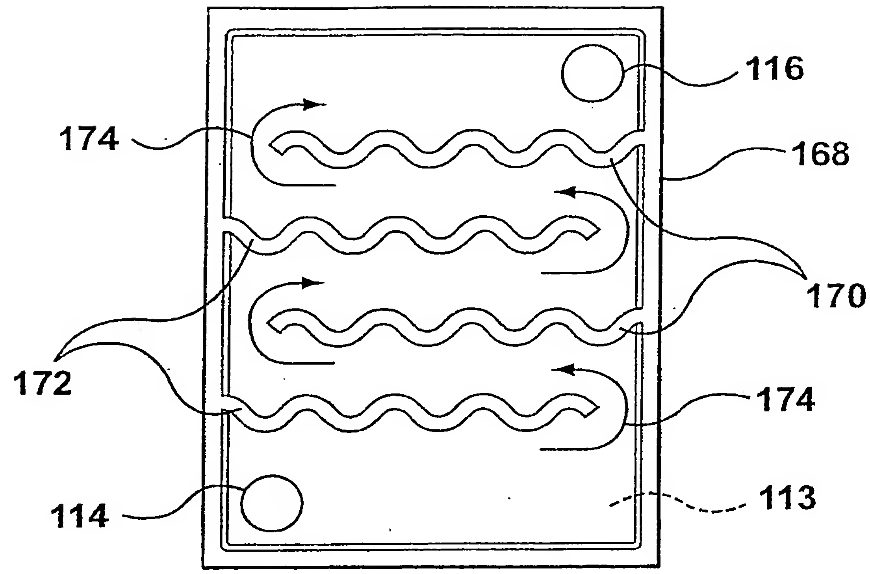

FIG. 18

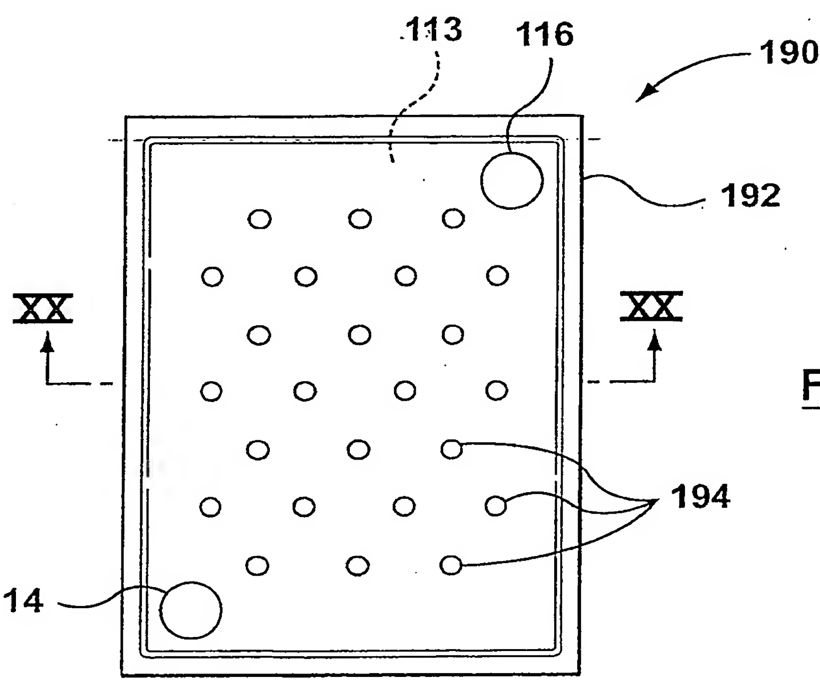

FIG. 19

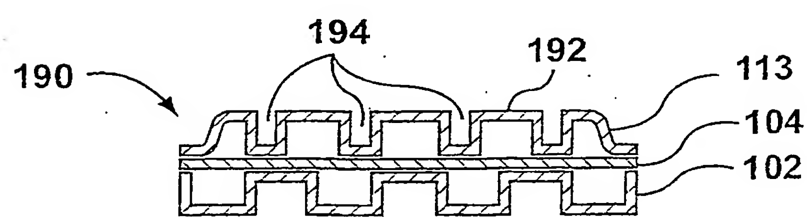

FIG. 20

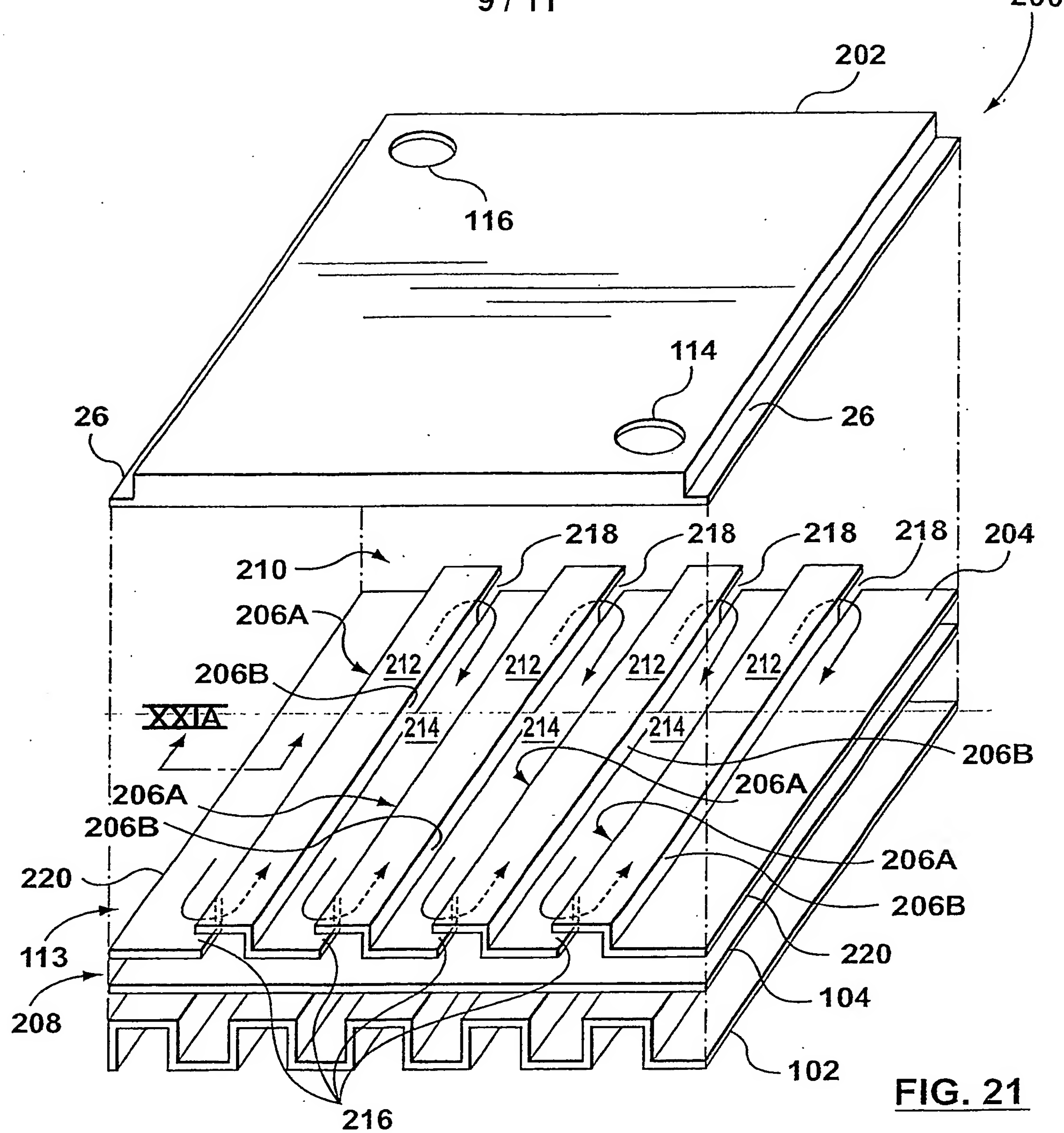

FIG. 21

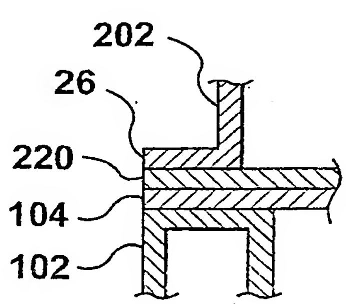

FIG. 21A

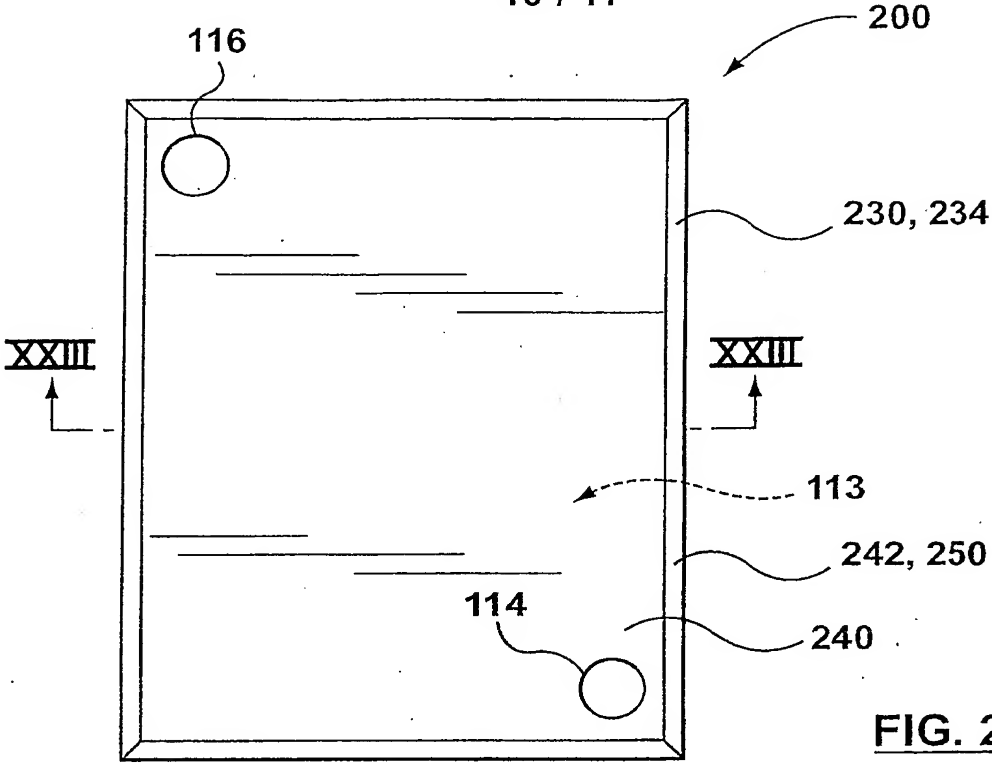

FIG. 22

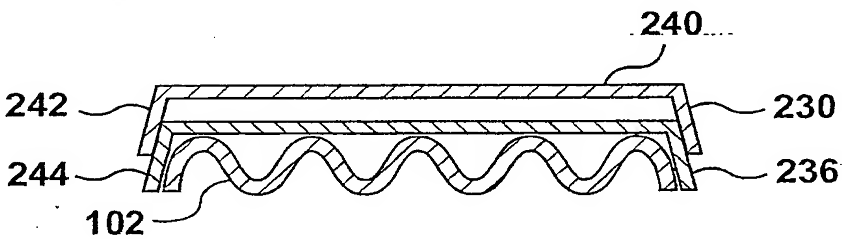

FIG. 23A

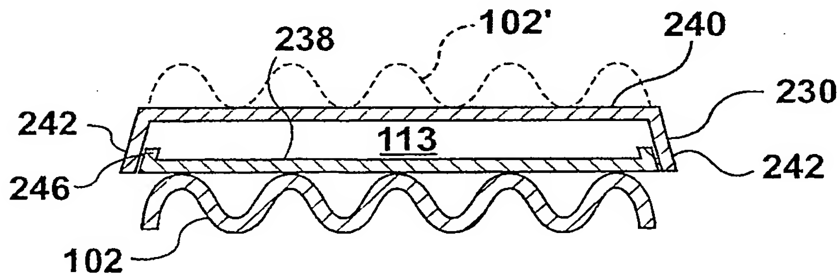

FIG. 23B

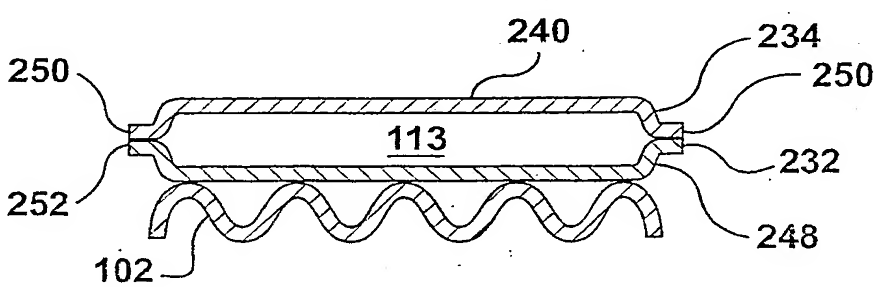

FIG. 23C

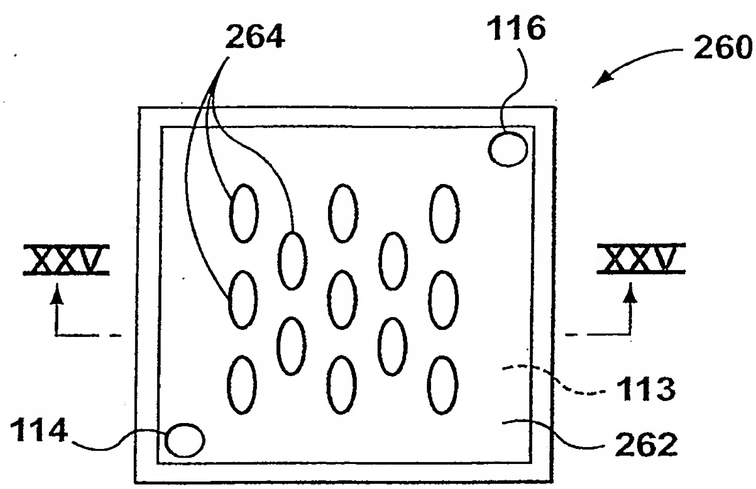

FIG. 24

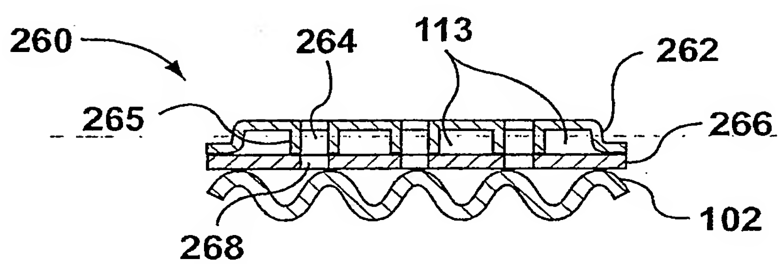

FIG. 25

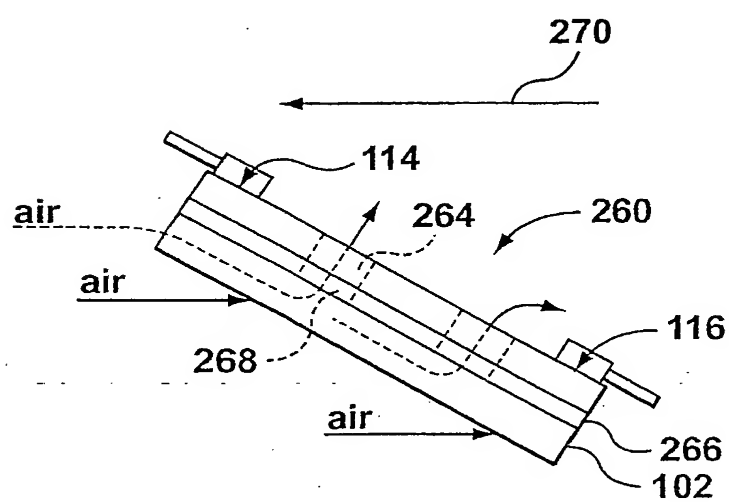

FIG. 26

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F28D1/03 F28F3/02 F28F3/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F28D F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 297 22 841 U (SANDER KG GMBH & CO) 12 February 1998 (1998-02-12) the whole document	1,7-9,18 14
Y	EP 0 907 061 A (BEHR GMBH & CO) 7 April 1999 (1999-04-07) figure 5	14
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 02, 29 February 1996 (1996-02-29) -& JP 07 280484 A (CALSONIC CORP), 27 October 1995 (1995-10-27) abstract; figures	1,4,5,8,9,16,18
A	FR 1 189 606 A (FORD FRANCF S A) 5 October 1959 (1959-10-05) the whole document	1-21

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 May 2003	05/06/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mootz, F

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 002 200 A (RASKIN WALTER) 11 January 1977 (1977-01-11) abstract; figures ---	1-21
A	EP 0 826 874 A (VOLKSWAGENWERK AG) 4 March 1998 (1998-03-04) column 4, line 40 -column 5, line 34; figures 3-5 ---	1-21
A	US 2 796 239 A (CAUGHILL ROBERT F ET AL) 18 June 1957 (1957-06-18) the whole document -----	1-21

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